

Study on the Provenance of *Fraxinus Mandshurica*

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ABSTRACT This paper studied that the significant difference exists among the ten provenances of 9-year-old *Fraxinus mandshurica* stand. The rule of geographic variation is that dual continuous changes with longitude and latitude, and the provenance in the southwest range grows rapidly. There are positive significant correlation when the tree growth is influenced by $\geq 10^{\circ}\text{C}$ accumulated temperature, duration of sunshine and annual precipitation. So it is suggested that Lushuihe and Maoershan provenances should be employed first in Maoershan Forest Farm and its neighborhoods.

Key words: *Fraxinus mandshurica*, Geographic variation, Provenance selection

this region were summarized in this paper.

INTRODUCTION

Fraxinus mandshurica is a primary accompanying species of the top-grade population of the broadleaf forest in northeast China. It distributed widely in the areas of secondary forest. It is possible that the provenances with different genetic structure have been taken shape as a result of long-term intraspecific selection. In the recent years, the artificial silviculture area for this species progressively increased, but the study on the provenance is little. In order to select the good provenance for the Southern Heilongjiang province, divide seed region, found out the rules for seed allocation, we have carried out the provenance test of *Fraxinus mandshurica* since 1985. The preliminary results of the provenance for

MATERIALS AND METHODS

Source of Materials The seeds of ten provenances were collected in 1985. The sites of seed collection were determined according to the environment factors of its natural distribution range, such as the longitude, latitude and climatic condition etc. The stands of seed collection must be the natural forest, and grow well. The tree-age was between 40-60 years old. The seeds of 15 individual trees in every provenance was collected. The geographic sites of all provenances were listed in Table 1.

Table 1. The geographic site of provenances

Provenances	Shulan	Lushuihe	Dongfanghong	Huanan	Mulan	Maoershan	Dailing	Yingchun	Dahailin	Yuanbao
Latitude	4425	4230	4607	4612	4657	4520	4710	4607	4426	4520
Longitude	12856	12800	13306	13030	12802	12734	12853	13306	12856	12734
Height (m)	212	730	400	182	112	300	500	400	345	300

The Method of Experiment The site of experiment situated in the Maoershan Experiment Forest Farm of Northeast Forestry University. The seedlings were raised on seeding bed in 1986. The seedlings were planted in the spring of 1987. The six replicate plots were designed in the silviculture. Each plot had 52 individual seedlings arranging in four rows. The plant-row spacing is 1m \times 2m. There were two-row local provenances (*Pinus koraiensis*) around the experimental plot. *Pinus koraiensis* is planted every other plot.

The investigation was taken in the spring of 1996. Six individual trees with the age of 9 were measured in

each plot. The measured traits included height and ground diameter of tree trunk.

Statistical Method In order to determine if the genetic variation exist between the provenances, the two-way analyses of variance were employed. On the basis of analysis of variance, we used simple collection and trend surface analysis to study the continuous change trend of provenance for *Fraxinus mandshurica*. The first step of trend surface analysis is to fit quadratic duality equation:

$$Y = b_0 + b_1x_1 + b_2x_2 + b_{11}x_1^2 + b_{22}x_2^2 + b_{12}x_1x_2$$

where:

Y -- the measured traits (height and diameter of trees)

x_1 --the longitude of provenances

x_2 --the latitude of provenances

b - the regression coefficient

Then the stepwise regression was made to select the important variables for the equation, and the significant difference is tested among provenances. If the difference is significant, the trend surface is plotted for charts according to the above equation. Finally we use these charts to analysis the rules of geographic variation.

RESULTS AND ANALYSIS

The Geographic Variation of Provenance for *Fraxinus mandshurica* The analyses result of *Fraxinus mandshurica* were listed in the Table 2. The all differences among provenances had reached the significant level. This result showed that there were significant differences among genetic base of provenance for *Fraxinus mandshurica*. For example, the mean tree height and diameter of Lushuihe provenance was 2.08 m and 2.91 cm respectively, while that of Huanan provenance was only 1.28 m, and 1.61cm.

Table 2. The analyses of variance for the main traits of *Fraxinus mandshurica*

Traits	Mean	Ranges	F-value	Significance level
Height (m)	1.569	1.28-2.08	2.684*	0.0228
Diameter (cm)	2.096	1.61-2.92	2.430*	0.0129

Note: * stand for 0.05 significance level

The Rules of Geographic Variation The simple correlation analysis of tree height and ground diameter with different test site were listed in Table 3. The results showed that there were a little negative correlation between traits and longitude with 0.10 significance level, so that the height and ground diameter for *Fraxinus mandshurica* increased with the decreasing of longitude. The correlation coefficient of the height and latitude reached the significant level, and the ground diameter with longitude reached the very significant level. All of the correlation was negative, so that the tree height and ground diameter decreased with the increasing of latitude. The correlation of tree height and ground diameter with elevation did not reach significant level. These analysis showed that the geographic variation for *Fraxinus mandshurica* was controlled by the longitude and latitude. The height and ground diameter of provenances trees decreased from south to north and from west to east.

In order to know well the combining continuous changes, the trend surface analysis is carried out. The quadratic duality equation is listed in Table 4. The regression equation has reached significant level, so we use these equations to plot the surface and contour chart from

Fig. 1 to Fig. 2.

Table 3. The correlation of provenances traits and geographic site and its significant level

Traits	Items	Longitude	Latitude	Height
height	correlation	-0.605 ³	-0.668*	0.315
	significance level	0.064	0.035	0.376
ground diameter	correlation	-0.589 ³	-0.811**	0.354
	significance level	0.0731	0.0044	0.316

Note: A, *, **, stand for 0.10, 0.05, 0.01 significant level respectively

Table 4. The quadratic duality equation

Traits	Regression equation	Determined coefficient	Significant level
Height	$y = 13.3664 - 0.0539x_1 - 0.0107x_2$	0.5697*	0.0217
Diameter	$y = 308.5131 - 2.3009x_1 - 0.5568x_2 + 0.0492x_1x_2$	0.8561**	0.0019

Notes: x_1 and x_2 stand for longitude and latitude respectively; * and ** stand for 0.05 and 0.01 significant level respectively

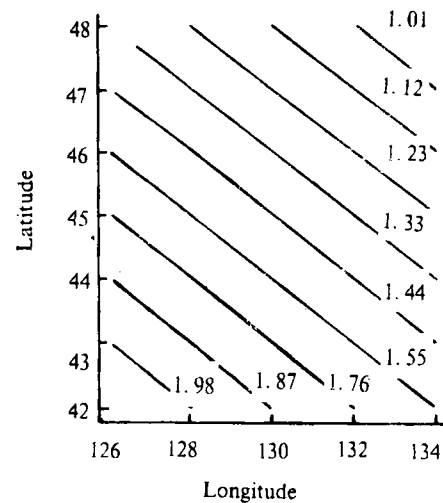


Fig. 1. The trend surface of tree ground diameter

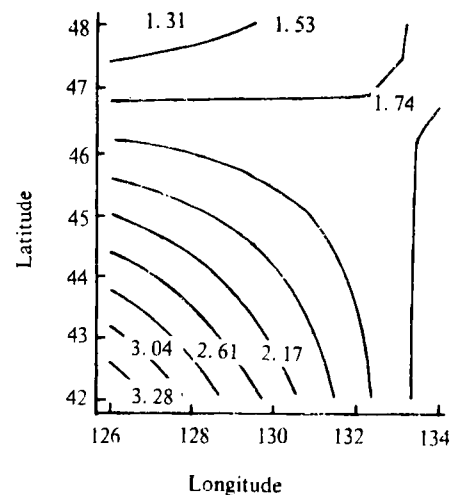


Fig. 2. The contour chart of ground diameter

From Figure 1 to Figure 2, it is confirmed that the growth of *Fraxinus mandshurica* have dual continuous changes with longitude and latitude.

In order to find the climatic factors which influence the geographic variation of provenances, we also calculate the correlation between traits and climatic factors (Table 5). The growth of *Fraxinus mandshurica* is

mainly influenced by the $\geq 10^{\circ}\text{C}$ accumulated temperature, mean annual precipitation, annual duration of sunshine. They have positive correlation. The result shows that the provenances grow rapidly when it is higher accumulated temperature, large precipitation, long duration of day.

Selection of Best Provenance The test of Least significance difference (LSD) is carried out for the tree height and ground diameter (Table 6). The result shows that the growth of Lushuihe and Maoershan et al. provenance are good in both tree height and ground diameter. The rate of the best height and ground diameter in Lushuihe provenance was 61.8% and 114.9 respectively, over than that of Huanan provenance (32.3% and 39.3%), over than the mean value of provenance (8.9% and 35.9%), also over than the local provenance. It is

Table 6. Multiple range test for height and ground diameter of *Fraxinus mandshurica* provenance

Provenance	Mean height (m)	LSD		Provenance	Mean ground diameter (cm)	LSD	
		0.05	0.01			0.05	0.01
Lushuihe	2.076			Lushuihe	2.918		
Maoershan	1.790			Shulan	2.400		
Shulan	1.706			Yuanbao	2.288		
Yuanbao	1.688			Maoershan	2.222		
Mulan	1.644			Mulan	2.138		
Yingchun	1.458			Dahailin	2.112		
Dahailin	1.422			Yingchun	1.878		
Dongfanghon	1.332			Dongfanghon	1.782		
Dailing	1.292			Huanan	1.618		
Huanan	1.280			Dailing	1.606		

CONCLUSION

The significant difference exists among the ten provenances of the nine years old *F. mandshurica* is. The rule of geographic variation for *F. mandshurica* is that the growth has dual continuous changes with longitude and latitude, and the provenances of the southwest in its natural range grow more rapidly. There are positive significant correlation when tree growth is influenced by the environment factor, such as $\geq 10^{\circ}\text{C}$ accumulated temperature, duration of sunshine and annually precipitation. It is suggested that Lushuihe and Maoershan provenances should be employed first in Maoershan Forest Farm and its neighborhoods.

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Table 5. The correlation of provenance traits and climatic factors

Traits/item		Mean annually temperature	$\geq 10^{\circ}\text{C}$ accumulated temperature	Annually precipitation	Duration of day
Height	Correlation	0.482	0.619 ^Δ	0.704*	0.686*
	Significant level	0.158	0.056	0.023	0.041
Ground Diameter	Correlation	0.512	0.579 ^Δ	0.670*	0.619 ^Δ
	significant level	0.134	0.079	0.034	0.076

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(Responsible Editor: Zhu Hong)